XBT Data Flow and Quality Control at AOML

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AOML (and SIO) XBT Data Flow

SEAS
Real Time (RT)
Transmissions

NCEI / GTSPP

SEAS
Server

GTS

Delayed Time (DT)
Data Download

RT Profiles
for QC

QC Result

AOML AQC/VQC (RT)
AOML Expert QC (DT)

AOML XBT
Website

AOML XBT AQC Procedure (RT)

AOML updated its XBT AQC procedures during 2015-2016 and is currently transitioning to the new system.

AOML's XBT AQC tests:

- **Date**
- **Constant Value**
- **Location**
- **Depth**
- **Gross**
- **Vertical Gradient**
- **Spike**
- **Climatology**
- **Analysis**

AQC Flags:

- ✓ 0 - Not Enough Data
- ✓ 1 - Passed Check
- ✓ 4 - Failed Check
- ✓ 9 - Runtime Error

AOML XBT AQC Procedure (RT)

- **Date** (Global flag) : Checks for impossible date and time

Good if:

Year ≥ 1997

1 ≤ Month ≤ 12

1 ≤ Day ≤ corresponding max

0 ≤ Hour ≤ 24

0 ≤ Minute ≤ 60

- **Constant Value** (Global Flag): checks if the profile is constant from top to bottom

Good if:

$T_{min} \neq T_{max}$

AOML XBT AQC Procedure (RT)

- **Location** (Global Flag): Checks for impossible locations

Good if:

-180 ≤ Longitude ≤ 180

-90 ≤ Latitude ≤ 90

- **Depth** (Global Flag): Checks for profiles located at sea

Now using ETOPO1 (from 2013, 0.25° resolution)

Previously using ETOPO5 (from 2003, 1° resolution)

AOML XBT AQC Procedure (RT)

- **Gross** (Global Flag): Checks extreme depth and temp. values

Good if:

$-2.5\ ^{\circ}C \le T \le 40\ ^{\circ}C$

$0\ m \le Z \le 2000\ m$

Previously: $0\ m \le Z < 11{,}000\ m$

- **Vertical Gradient** (Local Flag): Checks the gradients and inversions for decreasing and increasing temperatures

Good if:

$(T_2 - T_1) < 0$ **and** $|(T_2 - T_1) / (Z_2 - Z_1)| < 1.0\ ^{\circ}C/m$ **or**

$(T_2 - T_1) / (Z_2 - Z_1) < 0.2\ ^{\circ}C/m$

AOML XBT AQC Procedure (RT)

- **Spike** (Local Flag): Checks that the observed temperature is not the median (of 5 points) and that the difference between the observed temperature and the mean (of 5 points excluding the observed temp.) is greater than 0.3 °C

Fail if (a spike is flagged):

$| T_3 - \text{median}(T_1, T_2, T_3, T_4, T_5) | \neq 0$ **and**

$| T_3 - \text{mean}(T_1, T_2, T_4, T_5) | > 0.3$ °C

Previously: $| T_2 - \text{median}(T_1, T_2, T_3) | > 0.4$ °C

ARGO: $| T_2 - (T_3 + T_1) / 2 | - | (T_3 - T_1) / 2 |$ > Test Value

Glider IOOS: $| T_2 - (T_3 + T_1) / 2 | > 0.05$ *fail*

$0.02 \text{ °C} < | T_2 - (T_3 + T_1) / 2 | < 0.05$ °C *questionable*

AOML XBT AQC Procedure (RT)

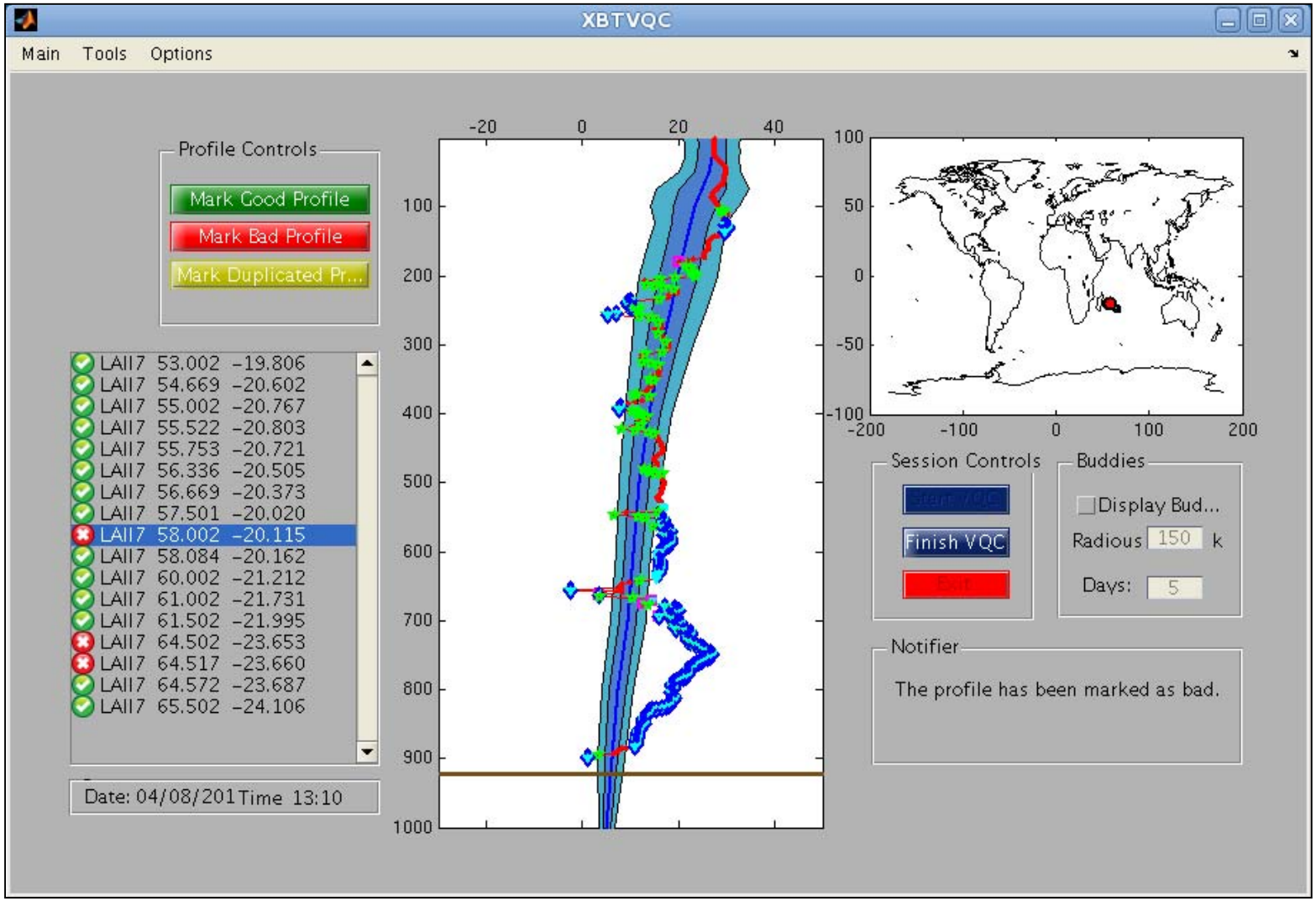
- Climatology (Local Flag): Compares the XBT profile with *Levitus* WOA climatology. A measurement fails this test if it is outside the 3 standard deviations envelope around the mean profile.

  Using 2013 WOA climatology

  Previously using 2001 WOA climatology

- Analysis (Local Flag): Compares the profile with NCEP's weekly analysis data. A measurement fails this test if it is outside the 3 standard deviation (from *Levitus WOA 2013* climatology) envelope around the mean profile.

AOML XBT VQC Procedure (DT)



AOML XBT Delayed Time Expert QC

Delayed-Mode XBT data processing is performed mostly for scientific applications with XBT observations in high-density mode.

In addition to the RT QC test, Delayed Mode QC Tests includes:

- Ship Speed
- Profile Location (Map)
- Duplicates
- Hit Bottom
- Local Climatology
- **Visual QC**

Profiles are modified during the Expert (science quality) QC

AOML XBT Binary Format (new metadata)

Metadata:

Station No.	GTS CRC	XBT Serial No.
Latitude / Longitude	Recorder Type	Ship Name
Date / Time	Recorder Code	Call Sign
AmverSEAS Version	XBT Type	IMO No.
SEAS ID	XBT Code (FRE)	Transect Name

Data: (RT) Temperature / Depth
(DT) Pressure / Potential Temp. / Salinity (WOA13) / Dyn. Height

AOML XBT New Binary Format (new metadata)

Additional Metadata (in SEAS bin and BUFR bulletins):

Dry Bulb Temp.
Wind Inst. Type
Wind Speed
Wind Dir
Current Meas. Method
Current Speed
Current Dir.
Bottom Depth

Ship Speed at Launch
Ship Dir. At Launch
Profile Sequence No.
Transect Number
Launch Height
Autolauncher Type
Recorder Serial No.
Rec. Manufacture Date

XBT Manufacture Date
Agency
Ship Rider Name
Ship Rider Institution
Ship Rider Email
Ship Rider Telephone

Additional metadata is part of Amverseas new binary format. It is included in the BUFR bulletins (GTS) and AOML XBT data distributed through AOML's XBT website

Future Work

- Implement the new AQC procedure operationally
- Add all AQC flags in the BUFR bulletins submitted to the GTS
- Send additional metadata to GTSPP
- Distribute XBT data with profiles according to *Hanawa et al. 1995* (H95) and the recommended correction by *Chen et al 2014* (CH14). Also include the correction for depth offset due to the deployment height described in *Bringas and Goni, 2015* (BG15).

BG15: Bringas, F. and G. Goni. *J. Atmos. Oceanic Technol.*, 32, 2253–2263 (2015)
CH14: Cheng et al. *J. Atmos. Oceanic Technol.*, 31, 1793–1825 (2014)
H95: Hanawa et al. *Deep-Sea Res.*, 42, 1423–1451 (1995)